

Predictor of Stunting Among Children 0-24 Months Old in Indonesia: A Scoping Review

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Abstract

Stunting, a condition of impaired growth and development due to chronic malnutrition, remains a significant challenge in Indonesia. Efforts to address this issue have been hindered by an inadequate understanding of the predictors of stunting, particularly in the first 1000 days of a child's life. To address this gap, a scoping review was conducted to identify factors influencing stunting in children aged 0-24 months in Indonesia. The review focused on observational studies published from 2012 to 2023, retrieved from five international databases using specific keywords. Among the 16 articles, 10 factors with 26 predictors emerged, spanning child, mother, home, inadequate complementary feeding, inadequate breastfeeding, poor quality foods, infection, political economy, health and healthcare, and social culture factor. Most predictors aligned with mother, child, and home factors. These findings provide a foundation for targeted interventions and collaborative efforts across sectors to combat stunting and ensure healthier futures for Indonesia's children.

Keywords: *Indonesia predictor; influencing stunting; 0-24 months children*

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Introduction

Stunting is a severe and irreversible manifestation of physical, psychological, and cognitive impairment caused by chronic malnutrition, particularly during the first 1000 days of life (Olo et al., 2021; Otiti & Allen, 2021; WHO, 2015). It arises from a multitude of direct and indirect factors, encompassing breastfeeding history, low birth weight, short maternal stature, socioeconomic status, environmental and sanitation conditions, and access to healthcare services (Amaha & Woldeamanuel, 2021; Nshimiyiryo et al., 2019; Titaley et al., 2019). These factors lead to significant health and developmental setbacks for children, yielding both short-term and long-term consequences (Badriyah & Syafiq, 2017). In the immediate timeframe, stunting hampers brain development, impairs physical growth, and may lead to metabolic disorders, while in the long term, it can result in reduced cognitive ability, hindered learning achievement, decreased endurance, and increased risks of other complications (De Sanctis et al., 2021; Torlesse et al., 2016). Of utmost concern is stunting's contribution to 17% of under-five deaths (Black et al., 2013), underscoring the urgent need for comprehensive interventions and policies to combat stunting and its devastating consequences.

Many cases underscore the irreversible nature of stunting, especially when it emerges within the first 1000 days of child's life, becoming a significant impediment to further developmental progress (Fentiana et al., 2022; Laksono et al., 2022). Given its significant impact on child health, stunting poses a serious global health problem, particularly prevalent in developing and impoverished countries, with rates reaching 22.4% and 35.2%, respectively (Titaley et al., 2019; UNICEF & WHO, 2021). Indonesia, as one of these developing countries, faces a stunting prevalence of 21.6% and has also initiated a national stunting reduction program (Kementerian Kesehatan Republik Indonesia, 2022; Siswati et al., 2022). This program includes various integrated nutrition-specific and nutrition-sensitive interventions, aiming to reduce stunting to 14% by 2024 (Kemenkes RI, 2018; Sesneg RI, 2020). However, despite these efforts, the interventions have been deemed insufficient, as the reduction in stunting achieved in 2022 was only 2.8%, falling short of the annual target of 3-3.5% (Kemenko PMK, 2022). Further concerted efforts and improvements in intervention strategies are essential to address this pressing health issue and improve the well-being of Indonesia's children.

The inability to achieve the target in reducing stunting rates can be attributed to existing stunting interventions not adequately addressing the multifaceted factors and/or predictors that should have been targeted, as highlighted by Wali et al. (2020). Recent studies have shed light on some of these crucial factors and/or predictors, including energy intake (Nugroho et al., 2021), dietary diversity (Ahmad et al., 2018), birth weight (Maryati et al., 2023), family income (Sairah et al., 2023), parenting style (Krisnana et al., 2020), maternal factor (Santosa et al., 2022), antenatal care (Mediani et al., 2023), and water and sanitation factors (Olo et al., 2021). However, it is important to note that these factors and/or predictors of stunting have not been specifically tailored to the critical first 1000 days of child's life in Indonesia, as elucidated by Beal et al. (2018) and Wicaksono et al. (2021). Recognizing the critical importance of understanding stunting predictors, we conducted a scoping review with the goal of identifying the predictors of stunting among children 0-24 months in Indonesia. We also aimed to summarize these predictors within the framework provided by the World Health Organization's stunting conceptual framework. This approach serves to facilitate the development of more effective interventions and to inspire further exploration of predictors that currently lack clear evidence. By gaining a deeper understanding of and effectively addressing the predictors of stunting, Indonesia can implement targeted, evidence-based interventions. This, in turn, can contribute to substantial progress in reducing stunting prevalence and ultimately improve the health and development of its young population.

Methodology

This scoping review conducted by following the guidelines of the Joanna Briggs Institute (JBI) methodology for Scoping reviews (Peters et al., 2020) and reported using the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) extension for Scoping Reviews (Tricco et al., 2018). The steps included developing objectives and research questions, determining inclusion and exclusion criteria for data on evidence, planning search strategies, determining sources of evidence selection, data extraction, analysis of evidence, and presenting results (Peters et al., 2020).

To formulate the review question, the Population, Concept, and Context (PCC) framework was applied. The population of interest comprised children aged under 24 months, the concept focused on predictors of stunting, and the context was Indonesia.

The search for relevant articles was conducted in five international databases (MEDLINE/PubMed, CINAHL Plus with Full Text via EBSCOhost, Web of Science, Scopus, and Cochrane Library) up to March 14, 2023. The search used Medical Subject Heading (MeSH) descriptors, and the terms were not limited to "stunting" OR "growth disorder" AND "infant" AND "epidemiologic factor" AND "Indonesia". The full search strategy is provided in Table 1 (attached).

To ensure the inclusion of recent and specific predictors of stunting in Indonesia, the review applied two important search limitations. First, only peer-reviewed articles in English or Bahasa published between January 2012 and February 2023 were included. Second, the geographic location of the studies was limited to Indonesia. The review focused on original studies with observational designs and secondary data analysis, as the nature of the study is essentially observational and retrospective. Any relevant full-text articles that were not found during the initial search were excluded, and efforts were made to contact the authors for additional information if necessary.

After collating and removing duplicates using the Rayyan website application (Ouzzani et al., 2016), the first authors screened titles and abstracts, and relevant articles were retrieved in full text and assessed in detail based on the inclusion criteria by all authors independently. The article selection process was recorded and reported in the PRISMA 2020 flow diagram (Page et al., 2021). Any disagreements among authors during the selection process were resolved through discussion.

Data extraction was performed independently by all authors using the JBI data extraction instrument developed for this review. The data extraction included article characteristics, study objectives, population details, and outcomes. For article characteristics, authors, year of publication, country of origin, and study design were extracted. Population data included sample size and main criteria. Outcome data focused on predictors of stunting found in children aged 0-24 months, along with their measure of association (OR, RR, HR). Disagreements in the data extraction process were resolved through discussion.

This scoping review presents two tables of data extraction results, which were agreed upon by all authors, along with a narrative summary of the findings. The first table describes the characteristics of the articles and the identified predictors of stunting. The second table provides a summary of the predictors of stunting, categorized by factors from the WHO stunting conceptual framework (WHO, 2016). The narrative summary focuses on describing the number of existing predictors of stunting and the most common predictors found in Indonesia.

Result and Discussion

The identification and screening of 839 articles resulted in 16 studies that met the inclusion criteria, while 823 articles were excluded based on the PRISMA-ScR flow diagram (Figure 1). Among the 16 studies, secondary data analysis was the most commonly used study design (5/16 studies), followed by case control (4/16 studies), cross-sectional (4/16 studies) and cohort (3/16 studies) designs (Table 2).

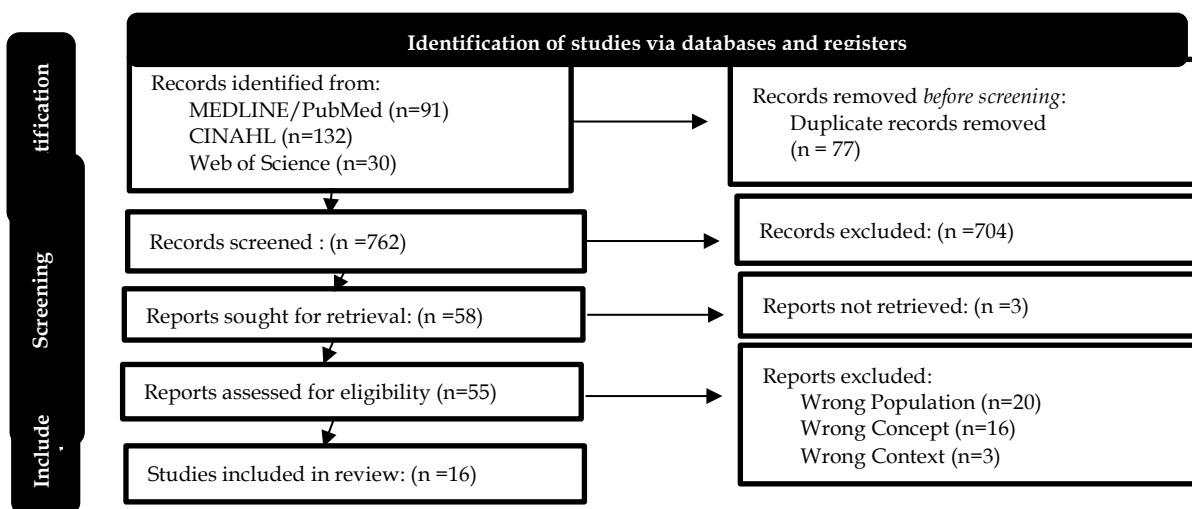


Figure 1. Identification of studies via databases and registers

By adapting the WHO stunting conceptual framework (WHO, 2016), we identified 10 factors related to stunting in Indonesia (Figure 2). Those factors include the child, mother, home, inadequate complementary feeding, inadequate breastfeeding, poor quality foods, infection, political economy, health and healthcare, and social culture factor. Each factor has its own predictors, resulting in a total of 26 predictors. Our summary shows that the most common factor of stunting in Indonesia is mother factors with 6 predictors.

Of the 26 predictors, we discovered 11 new predictors that were not previously included in the WHO stunting conceptual framework (WHO, 2016). Interestingly, the most predictors were related to child and mother factors with four predictors each. This may indicate that child factor, which were previously associated with the consequences of stunting, are just as crucial as mother factor as a contributing factor to stunting in Indonesia. The remaining three new predictors were categorised into two factors: the home and inadequate complementary feeding.

Based on reported measures of effect, low caregiver education (≤ 9 years) has the largest relative ratio, increasing the risk of stunting in Indonesia by up to two times (Gunardi et al., 2018). Additionally, the odds of stunting in children aged 0-24 months are increased by more than five times due to several predictors, including unemployed mothers (aOR 8.40) or mothers working as farmers/breeders (aOR 11.74) (Hadi et al., 2021), infrequent feeding (OR 6.33) (Puspita et al., 2022), and short parental height (mother < 145 cm and father < 161.9 cm; aOR 5.93) (Sari & Sartika, 2021). Specifically for complementary feeding, a study found that a combination of poor complementary feeding practices and quality increased the odds of stunting by eight times. (OR 8.26) (Hijra et al., 2016). However, since this review is the first to discuss predictors of stunting in children aged 0-24 months in Indonesia, further studies are urgently needed to gain a better understanding of predictors of stunting in the country.

Child factor

In the child factor, while it was not initially established as a contributing factor to stunting within the WHO stunting framework, our review has revealed several critical predictors of stunting in Indonesia. These predictors include birth weight, birth length, gender, and age. However, it is important to note that two of these predictors, namely the age and gender of the child, are inherent and cannot be modified.

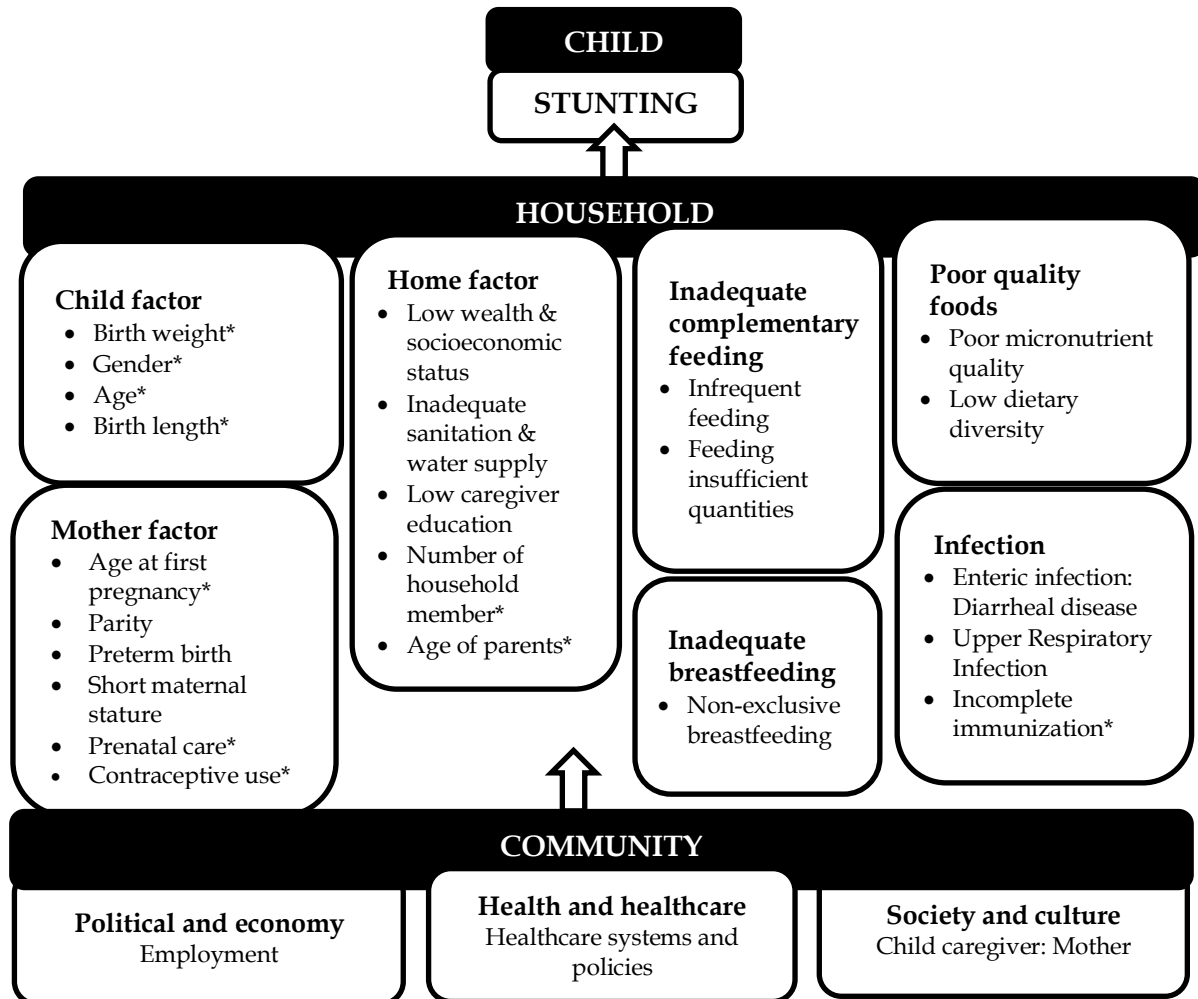
This discovery closely aligns with the findings of a prior review conducted by Ummah and Mediani (2023), which specifically delved into the proximal factors of stunting in toddlers within Indonesia and other developing countries. Their review identified birth weight and birth length as proximal factors significantly associated with stunting in toddlers. Furthermore, another previous review by Yani et al. (2023) explicitly underscored the significance of the age and gender of the child as substantial predictors of stunting.

Among the predictors found, short birth length (< 48 cm) stands out as having the most substantial impact on stunting, particularly within the first six months of life (Hijra et al., 2016). This finding is consistent with prior studies that also highlights short birth length as a significant predictor to stunting (Hastuti et al., 2020; Thahir et al., 2023). This condition is often an indicator of inadequate fetal growth and can result from factors such as poor maternal nutrition, maternal health problems, and placental insufficiency (Gonete et al., 2021; Jamshed et al., 2020). Furthermore, a study revealed that 23% of children with short birth length children also had low birth weight (Madinar et al., 2021), further underscoring the interconnectedness of these predictors.

LBW children are four times more likely to be stunted in their first month of life (Sartika et al., 2021). While children with low birth length and weight may initially avoid stunting effects until around six months of age, they become highly susceptible if not provided with sufficient breastfeeding and appropriate complementary foods during the critical golden period (Aryastami et al., 2017; Kusuma & Nuryanto, 2013). These findings highlight the crucial

role of proper nutrition and care during early infancy to mitigate the risk associated with short birth length.

While the age and gender of the child are inherent and cannot be modified, understanding their influence on stunting is crucial for targeted interventions and policy considerations to address stunting effectively. Meanwhile, factors like birth weight and birth length offer opportunities for interventions aimed at improving maternal health, nutrition, and antenatal care to potentially mitigate the risk of stunting.



*Newly added predictors

Figure 2. Conceptual framework of stunting for children aged 0-24 months in Indonesia

Mother factor

The mother factor emerges as a crucial causal factor with the most predictors of stunting, making it an important target for stunting prevention efforts. Among the six predictors found within this factor, the majority are closely related to pregnancy conditions. Given the significant impact of these predictors on stunting risk, it is imperative to address them starting from the preconception period. This involves focusing on maternal readiness for pregnancy, maternal nutrition before and during pregnancy, as well as proper care during childbirth and childcare.

This finding is in line with a prior review by Mediani et al. (2023) on stunting factors in developing countries. They found that maternal factors and antenatal care are two important factors that should be the focus of stunting management. Specific to the maternal factors, they found that it consisted of formal education, body mass index, height, age, mental health, and intention to pregnancy.

Notably, short maternal stature is the sole predictor not intertwined with pregnancy conditions, thus presenting challenges for intervention. As child height is chiefly shaped by genetic mechanisms (Zhang et al., 2015) and intergenerational effects (Khatun et al., 2019), addressing this factor required distinct strategies.

Regarding maternal readiness for pregnancy, the use of contraceptives emerges as a pivotal predictor warranting consideration, given its potential to curtail stunting risk by 2.25% (Fentiana et al., 2022). Contraceptive use facilitates birth regulation, promoting ideal spacing between pregnancies and fostering quality family planning. Moreover, planned birth spacing allows mothers adequate recovery time after childbirth and the provision of optimal care for their children (Fischer et al., 2018; Flood et al., 2019). Additionally, employing contraception can help prevent the risk of stunting associated with having too many children in a household (Yani et al., 2023).

Subsequently, bolstering maternal nutrition assumes paramount importance, with regular prenatal visits playing a pivotal role in mitigating stunting risk. Inadequate prenatal care visits during pregnancy elevate the likelihood of stunting threefold (Puspita et al., 2022). Promoting consistent prenatal care visits is essential in enhancing maternal knowledge about pregnancy, as well as child growth and development (Anis et al., 2022), thereby mitigating the occurrence of preterm births which also the predictor of stunting.

Lastly, we thought that the predictor of age at first pregnancy, associated with reduced stunting risk, is intrinsically tied to proper childbirth and care. Interestingly, both younger (15-19 years) and older (≥ 25 years) age at first pregnancy were shown to reduce the odds of stunting by 63% and 20%, respectively (Sari & Sartika, 2021). One study revealed that mothers aged ≥ 25 years are more likely to live in better conditions regarding sanitation, socioeconomics, education, and urban residence (Finlay et al., 2011). On the other hand, for younger age ranges, further research may be necessary to confirm and better understand these results.

The mother factor plays a pivotal role in stunting risk, with multiple predictors linked to pregnancy conditions. Addressing these predictors, especially through early and consistent prenatal care visits and supporting appropriate age at first pregnancy, can significantly contribute to reducing stunting prevalence in Indonesia. Targeted interventions during the preconception period and throughout pregnancy are crucial steps to improve maternal and child health and break the cycle of stunting in the country. Further research is needed to better comprehend the complexities of these predictors and design effective strategies to combat stunting effectively.

Home factor

The home factor, as a major contributor to stunting, encompasses various predictors that play both causal and contextual roles within the child's household. The predictors found are consistent with the findings in Yani et al. (2023) review on family household characteristics on stunting among children under five years old. They found that low levels of education and poverty in the household were the two main factors leading to poor quality and quantity of food and water, leading to inadequate nutrition and stunting.

Notably, low wealth and socioeconomic status increase the risk of stunting by two times (Torlesse et al., 2016). The availability of clean water for household consumption is also linked to stunting risk (Diana et al., 2021), as contaminated water can lead to chronic gastrointestinal diseases affecting nutrient absorption and linear growth, known as Environmental Enteric Dysfunction (EED) (Brander et al., 2019; Budge et al., 2019). Together with handwashing with soap, effectively eliminate bacteria and viruses on the hands and acting as a preventive measure to halt the spread and transmission of diseases (Khan et al., 2021). Thus, predictors within the home factors may not directly cause stunting in children aged 0-24 months but can mediate other predictors effects.

The number of family members also influences stunting risk. Larger family sizes, particularly those with low socioeconomic conditions, pose a higher risk of stunting (Victora et al., 2017). In families with more than four members, especially if there are multiple children and siblings under the age of five, the risk of stunting increases (Yani et al., 2023) due to potentially limited food rations. Economic demands rise with an increase in family members, making it challenging to meet the daily nutritional needs required to support child growth and development (Nur et al., 2021).

Among all predictors, caregiver education, especially maternal education, significantly impacts stunting risk in children aged 0-24 months. The literature consistently shows that the risk of stunting is notably higher when mothers have only completed primary school education or even less (Gunardi et al., 2018). This underscores the indirect influence of maternal education on stunting, as educated mothers are more likely to provide quality care to their children, starting from the prenatal period, as they possess the knowledge and understanding of their child's nutritional needs.

The home factor presents a comprehensive range of predictors influencing stunting risk within the child's household. Wealth and socioeconomic status, water supply, family size, and caregiver education (especially maternal education) are critical factors that demand attention for effective stunting prevention strategies. Addressing socioeconomic inequalities, improving access to clean water and sanitation, and promoting maternal education can contribute significantly to reducing stunting prevalence in Indonesia. Combining these interventions with comprehensive public health initiatives targeting the wider determinants of health can create a significant impact on improving child health and well-being and reducing stunting in the country. Further research is essential to better understand the intricate relationships between these predictors and their roles in mediating stunting risk.

Inadequate breastfeeding, complementary feeding, and poor-quality foods

These factors are three crucial contributing factors to stunting, as they directly impact child nutrition during the golden period. The risk of stunting is escalated threefold by non-exclusive breastfeeding (Puspita et al., 2022). Another studies have also shown that breastfed children have a lower risk of stunting compared to those who are not breastfed (Santosa et al., 2022), and that exclusive breastfeeding reduces the chance of stunting by 25% (Hadi et al., 2021). These findings indicate that children aged 0-6 month presents a pivotal window for stunting prevention through exclusive breastfeeding, which delivers age-specific essential nutrients crucial for early infant development within breast milk (Martin et al., 2016; Mediani, 2020). This finding further supported by a prior systematic review that identified exclusive breastfeeding as a significant protective factor against stunting in children under five years old (Rachmayanti et al., 2022).

When it comes to complementary feeding and poor-quality food consumption, infrequent feeding, poor micronutrient intake, and low dietary diversity have emerged as predictors elevating stunting risk (Hijra et al., 2016; Madinar et al., 2021; Nurhayati et al., 2020). Our findings consolidate several studies that have identified associations between feeding practices and the incidence of stunting in Indonesia, a pattern previously highlighted by Beal et al. (2018) in their review focusing on children aged 6-59 months. Additionally, these findings align with a review by Stewart et al. (2013), which presents a conceptual framework emphasizing the role of complementary feeding in the multifaceted factors contributing to stunting, along with its long-term and short-term consequences. They argue that community and societal conditions underpin infant and young child feeding practices, which are fundamental for healthy growth and development.

While vitamin D has been specifically linked to stunting in Indonesia (Nurhayati et al., 2020), more research on other micronutrients during the first 1000 days of child's life is still needed. In the context of dietary diversity, a research indicates that the likelihood of stunting is reduced by 83% when food groups encompass over four variations (Nurhayati et al., 2020),

a factor of significance given the tendency of Indonesia children exhibit less diverse diets (Basri et al., 2021). Then, Madinar et al. (2021) found that failing to meet the minimum acceptable diet increases the odds of stunting by 3.29, while Hijra et al. (2016) found that inadequate complementary feeding practices and poor quality had an odds ratio of 8.26 for stunting.

According to WHO and UNICEF (2021) regarding to Infant and Young Child Feeding (IYCF), appropriate feeding practices are crucial for fulfilling the child's nutritional needs. Feeding frequency should be adjusted according to the child's age, such as twice a day for breastfed infants aged 6-8 months, three times a day for breastfed children aged 9-23 months, and four times a day for non-breastfed children aged 6-23 months. Additionally, the diet should encompass at least five of the eight recommended food groups: breast milk; grains, roots, tubers and plantains; pulses (beans, peas, lentils), nuts and seeds; dairy products (milk, infant formula, yogurt, cheese); flesh foods (meat, fish, poultry, organ meats); eggs; vitamin-A rich fruits and vegetables; and other fruits and vegetables. Ensuring proper feeding practices according to the guidelines is vital for meeting the child's nutritional requirements during both breastfeeding and complementary feeding phases.

Infection factor

In this context, several predictors, including diarrhea disease, upper respiratory infection (URI), and incomplete immunization, have been identified as factors that increase the risk of stunting. These findings align with the results of a previous study conducted by Beal et al. (2018), which focused on children aged 6-59 months and also identified these three predictors as contributing to stunting due to infections in Indonesia. Specifically, children who experience gastrointestinal infections or upper respiratory infections are found to be at a significantly higher risk of stunting, with a fourfold and fivefold increase in susceptibility, respectively (Hijra et al., 2016).

Infections have a direct impact on children's nutritional status, affecting mechanisms such as appetite suppression, poor nutrient absorption, the activation of chronic immune responses, and other bodily reactions that hinder the assimilation of essential nutrients (Torlesse et al., 2016). Additionally, incomplete immunization is identified as a primary factor contributing to these infections (Shinsugi & Mizumoto, 2021), effectively doubling the likelihood of stunting (Sartika et al., 2021). A comprehensive immunization regimen equips the body with memory cells crucial for defending against infections and safeguarding children from preventable diseases (Theresia & Sudarma, 2022). Nonetheless, it's important to emphasize that further research is needed to fully understand the complex interplay of infectious factors and their profound impact on stunting within the specific context of Indonesia. In-depth exploration through additional studies will contribute to a more comprehensive understanding of this critical issue.

Political economy factor

Since we clustered wealth and socioeconomic status on the home factor, we did not add them back here, even though they overlap with this contextual factor. However, we did add a new predictor that corresponds to this factor, namely, maternal employment, for which the measure of association was not the same across reporting studies.

Hadi et al., (2021) reported that mothers working as farmers and laborers had higher odds ratios of 11.74 and 4.52, respectively, while maternal employment as farmers was associated with a risk ratio of 1.09 (Beal et al., 2018). Win et al., (2022) also supported the idea that employed mothers had a higher likelihood of having stunted children compared to non-working mothers. The impact of maternal employment on stunting may be influenced by factors such as income levels and parenting practices (Hosen et al., 2023). Working mothers might face challenges in providing optimal breastfeeding and complementary feeding to their children compared to non-working mothers.

However, the results also indicated that non-working mothers from rural areas with low socioeconomic status faced an 8-fold increased risk of stunting (OR 8.4) (Hadi et al., 2021). Gunardi et al. (2018) found that working mothers reduced the risk of stunting by 83% (RR 0.17) compared to non-working mothers. It is evident that the relationship between maternal employment and stunting is complex, influenced by various factors such as type of work, educational history, and regional context (Nankinga et al., 2019). To better understand and predict stunting incidence from these predictors, further studies are needed.

While our current study did not uncover significant political factors directly linked to stunting incidence, prior reviews by Palutturi et al. (2020) that have delved into the impact of political aspects on stunting rates have indicated that local and state leaders, who prioritize stunting management, can effectively reduce its prevalence. This commitment from political leaders is often exemplified through the implementation of programs and allocation of funds aimed at enhancing nutrition intake, providing necessary supplementation, improving environmental sanitation, and enhancing maternal and child health services. Nevertheless, it's worth noting that additional research at the local level is essential to gain a more nuanced understanding of how political factors specifically influence stunting incidence. Therefore, we recommend that further investigations be conducted in this area to shed more light on the intricate interplay between politics and stunting prevention in Indonesia.

Health and healthcare

In this factor, the quality of prenatal care emerges as a significant predictor of stunting incidence. In Hanifah et al. (2018) study, the prenatal care significantly predicts the incidence of stunting, with a relative risk (RR) of 12%. To elaborate, incomplete prenatal care was associated with an odds ratio of 1.22 for stunting (Titaley et al., 2019) while complete prenatal care was found to reduce the stunting rate by 2.56% (Fentiana et al., 2022). These findings underscore the critical importance of enhancing the quality of prenatal care as a fundamental element in preventing stunting. Prenatal care not only empowers maternal knowledge during and after pregnancy but also plays a pivotal role in monitoring fetal development.

While the contribution of prenatal care as a predictor is supported by the recent review conducted by Mediani et al. (2023), it is essential to recognize that the number of predictors within this category is comparatively limited when juxtaposed with the broader array of predictors summarized in the study by Beal et al. (2018), which concentrated on children aged 0-59 months. They identified that the health and healthcare factor consisted of healthcare quality, healthcare provider qualifications, healthcare infrastructure, and health systems and policies. This suggests that while focusing on the quality of prenatal care is crucial, further research is needed to uncover additional predictors of stunting in this context.

Society and Culture

According to a study by Hadi et al. (2021), societal and cultural factors play a significant role in child stunting, with mothers serving as the primary caregivers only experiencing a 38% odds of causing stunting. This finding suggests that when mothers are not the primary caregivers for their children, the incidence of stunting tends to be higher. The importance of mothers in preventing stunting during infancy and toddlerhood is further emphasized in a prior systematic review conducted by Saleh et al. (2021). This role encompasses various aspects, such as promoting nutrition through exclusive breastfeeding, providing high-quality complementary foods for infants, ensuring the availability of nutritious foods for children under five, and taking care of the environment, along with receiving family support to optimize children's growth and development.

Specifically in Indonesian culture, mother is also traditionally considered the main caregivers for their children, regardless of their employment status. Fathers in rural areas also view that the role of the mother as the primary caregiver as important, as only the mother can provide breastfeeding and meet the needs of the child's needs directly (Irianti et al., 2019;

McHale et al., 2014). It is assumed that when mothers directly care for their children, there is emotional closeness and increased attention to the child's growth. However, further studies are needed to strengthen these findings and comprehensively explore the impact of societal and cultural factors on stunting incidence in Indonesia.

Study limitations

While the research provides valuable insights into the factors contributing to stunting in Indonesia, there are several limitations that should be acknowledged. First, the findings might be specific to the context of Indonesia and may not be generalizable to other countries or regions with different cultural, economic, and healthcare landscapes. Second, we did not thoroughly explore potential interaction effect between different predictors. The combined impact of certain factor might be different than their individual effect. Third, while the study acknowledges cultural factors, the depth of understanding might be limited. Cultural nuances and complexities that influence caregiver roles, feeding practices, and health-seeking behaviors might not be fully captured. Forth, the analysis might not account for all potential confounding variables that could influence the relationship between predictors and stunting risk. Lastly, the studies used in the analysis might have methodological differences that introduce heterogeneity. This could impact the comparability of results and the overall conclusions. These limitations underscore the need for cautious interpretation and the potential for future research to refine our comprehension of stunting's multifaceted determinants.

Contribution to the area of public health policy

The comprehensive analysis of various factors contributing to stunting within Indonesia offers substantial insights that contribute significantly to the field of public health. This research not only identifies the complex web of elements influencing stunting but also lays the foundation for targeted interventions. These findings hold the potential to shape evidence-based strategies aimed at stunting prevention and mitigation. Public health initiatives can leverage the specific predictors highlighted in each factor to design tailored interventions. For instance, emphasizing the importance of exclusive breastfeeding during the first six months of a child's life, bolstering maternal nutrition and education, improving access to clean water, promoting proper complementary feeding practices, enhancing prenatal care quality, and recognizing the cultural significance of the mother's role can all contribute to a comprehensive public health approach.

Furthermore, this research underscores the interconnectedness of these factors and their cumulative impact on stunting risk. The recognition of how predictors within one factor can mediate the effects of predictors in other factors emphasizes the need for multi-dimensional interventions that address multiple determinants simultaneously. Ultimately, these findings provide a roadmap for public health practitioners, policymakers, and researchers to collaboratively work towards reducing stunting prevalence in Indonesia. By acknowledging the diverse range of factors contributing to stunting and developing targeted interventions, public health efforts can be more effective, leading to improved child health, development, and well-being across the nation.

Conclusion

The study explored and adapted the WHO stunting conceptual framework to identify factors and predictors contributing to stunting in Indonesia. A total of 10 factors were identified, including child, mother, home, inadequate complementary feeding, inadequate breastfeeding, poor-quality foods, infection, political economy, health and healthcare, and social culture factors. Among the 26 predictors identified, 11 were new and not previously included in the WHO framework, indicating their significance in the context of stunting children aged ≤ 24 months in Indonesia. Moreover, it underscores the importance of targeted

interventions during the preconception period, pregnancy, and the early years of a child's life to reduce stunting prevalence. Addressing factors related to maternal nutrition, caregiver education, household conditions, and child nutrition is vital for effective stunting prevention strategies. Further research is essential to gain a comprehensive understanding of predictors' roles and design evidence-based interventions to combat stunting effectively in Indonesia.

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Table 1. Search Strategy from Five Databases for Study Selection

Search	Terms	Results
MEDLINE/PubMed		
#1	"Growth Disorders"[MeSH Terms] OR "stunting"[All Fields] OR "growth stunted"[All Fields] OR "growth disorder"[All Fields]	42,105
#2	"Infant"[MeSH Terms] OR "infant, newborn"[MeSH Terms] OR "Infant"[All Fields] OR "neonates"[All Fields] OR "newborn"[All Fields]	1,478,108
#3	"Epidemiologic Factors"[MeSH Terms] OR "epidemiologic factor"[All Fields] OR "determinants"[All Fields] OR "epidemiologic determinant"[All Fields] OR "Risk Factors"[MeSH Terms] OR "risk factor scores"[All Fields] OR "risk scores"[All Fields] OR "population at risk"[All Fields] OR "health correlates"[All Fields] OR "social risk factors"[All Fields] OR "predict*"[All Fields]	3,702,932
#4	"asia, southeastern"[MeSH Terms] OR "Southeast Asia"[All Fields] OR "Southeastern Asia"[All Fields]	121,111
#5	#1 AND #2 AND #3 AND #4	140
#6	#5 AND ((2012/1/1:2023/2/28[pdat]) AND (english[Filter]))	91
CINAHL Plus with Full Text via EBSCOhost		
#1	MW "stunting" OR TX "growth disorders" OR TX "chronic malnutrition" OR TX "stunted, disorder" OR TX "stunting" OR MW "growth disorder"	6,484
#2	MW ("infant" or "newborn" or "neonate") OR TX ("infant" or "newborn infant" or "newborn" or "neonates")	404,466
#3	MW ("epidemiologic determinant" or "risk factor" or "population at risk") OR TX ("epidemiologic factors" or "determinants" or "risk factors" or "social risk factors" or "predict*" or "factors")	2,254,678
#4	TX ("Indonesia") OR TX ("Southeast asia" or "Southeastern asia")	22,684
#5	#1 AND #2 AND #3 AND #4	161
#6	#5 Limiters - Published Date: 20120101-20230231; English Language; Peer Reviewed	132
Web of Science		
#1	(((((TS=("stunting")) OR TS=("growth disorder")) OR ALL=("stunting")) OR ALL=("chronic malnutrition")) OR ALL=("disorder, stunted")) OR ALL=("stunted"))	15,028
#2	(((((((((TS=("epidemiologic factor")) OR ALL=("predict*")) OR ALL=("determinants")) OR ALL=("epidemiologic determinant")) OR TS=("risk factor")) OR ALL=("risk factor")) OR ALL=("social risk factor")) OR ALL=("risk scores")) OR ALL=("risk factor scores")) OR ALL=("population at risk"))	5,010,207
#3	(((((TS=("infant")) OR TS=("newborn infant")) OR ALL=("newborn")) OR ALL=("infant") OR ALL=("neonates")) OR TS=("neonate"))	434,720
#4	#1 AND #2 AND #3	397
#5	#4 AND English (Languages) AND INDONESIA (Countries/Regions)	30
Scopus		
#1	TITLE-ABS-KEY ("stunting" OR "growth disorder") OR ALL ("stunting" OR "growth disorder" OR "stunted, disorder" OR "chronic malnutrition")	59,280
#2	TITLE-ABS-KEY ("infant" OR "newborn") OR ALL ("infant" OR "newborn" OR "newborn infant" OR "neonates")	3,018,229
#3	TITLE-ABS-KEY ("epidemiologic factor" OR "determinant, factor" OR "determinant" OR "risk factor") OR ALL ("determinant factor" OR "Epidemiologic factor" OR "predict*" OR "determinant" OR "factor" OR "risk factor" OR "social risk factor" OR "risk scores" OR "risk factor scores")	28,283,038
#4	TITLE-ABS-KEY ("Southeast Asian" OR "South-eastern Asia") OR ALL ("Southeast Asia" OR "Southeast Asian" OR "Southeastern Asia" OR "South-eastern Asia")	389,920
#5	#1 AND #2 AND #3 AND #4	749

Search	Terms	Results
#6	#5 AND (LIMIT-TO (LANGUAGE , "english")) AND (LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012))	577
Cochrane Library		
#1	("stunting"):ti,ab,kw OR ("disorder, growth") OR ("disorder, stunted") OR ("chronic malnutrition") OR ("stunting")	1,342
#2	MeSH descriptor: [Growth Disorders] explode all trees	1,307
#3	("infant"):ti,ab,kw OR ("newborn infant"):ti,ab,kw OR ("newborn") OR ("infant") OR ("neonates")	88,412
#4	(neonates):ti,ab,kw	9,027
#5	MeSH descriptor: [Infant] explode all trees	39,686
#6	MeSH descriptor: [Infant, Newborn] explode all trees	20,292
#7	("epidemiologic factors"):ti,ab,kw OR ("epidemiologic determinant"):ti,ab,kw OR ("prediction") OR ("determinant") OR ("risk factors"):ti,ab,kw	80,650
#8	("social risk factor") OR ("risk scores") OR ("risk scores scores") OR ("population at risk")	2,090
#9	MeSH descriptor: [Epidemiologic Factors] explode all trees	58,374
#10	MeSH descriptor: [Risk Factors] explode all trees	32,696
#11	("Southeast Asian"):ti,ab,kw OR ("Southeastern Asia"):ti,ab,kw OR ("Southeast Asia")	663
#12	MeSH descriptor: [Asia, Southeastern] explode all trees	3,501
#13	(#1 or #2) AND (#3 or #4 or #5 or #6) AND (#7 or #8 or #9 or #10) AND (#11 or #12) with Publication Year from 2012 to 2023, with Cochrane Library publication date Between Jan 2012 and Feb 2023, in Trials	9

Table 2. Synthesis of the studies selected for the scope review

Authors/ Year	Design	Sample	Study Objectives	Findings
Torlesse et al/ 2016	Cross-sectional	1,366 children aged 0-23 months	To identify factors associated with stunting in children aged 0-23 months.	• Age of child (12-23 month; aOR 4.40)^{***} • Low household wealth^{**} (aOR 2.30) • Gender (male; aOR 1.45)^{**}
Sari et al/ 2021	Secondary data analysis	756 newborns	To determine the relationship between physical factors of parents and children with the incidence of stunting at birth	Stunting at birth • Age of mother at first pregnancy (15-17 y; aOR 0.37, 18-19 y; aOR 0.37, 20-24 y; aOR 1.34, ≥25 y; aOR 0.80)^{***} • Number of parities (one parity; aOR 2.31, two parities; aOR 2.04, three parities; aOR 1.70)^{***} • Preterm birth (aOR 2.12)^{***} • Short parental height (mother <145 cm, father <161.9 cm; aOR 5.93)^{***} • Age of parents (either parent 20-35 y; aOR 1.50, both parent <20 y or >35 y; aOR 2.37)^{***}
Hadi et al/ 2021	Secondary data analysis	408 caregivers of children aged 6-24 months	To examine the role of exclusive breastfeeding in reducing stunting prevalence among children under two years old attributable to low household expenditures in a lowincome Indonesian population	• Gender (male; aOR 1.51)⁺ • Exclusive BF (aOR 0.82)⁺ • Age of child (<12 mo; aOR 0.20)⁺ • Caregiver type (mother; aOR 0.38)⁺ • Maternal employment status: unemployed (aOR 8.40), labor/entrepreneur (aOR 4.52), farmer/breeder (aOR 11.74)⁺ • Monthly HH expenditure: <USD 15 (aOR 1.03), USD 15-<25 (aOR 2.00), USD 25-<37 (aOR 2.28), USD 37-<54 (aOR 1.20), >USD 54 (aOR 1)⁺
Gunardi et al/ 2018	Cohort	160 children aged <24 months	To identify parental socio-demographic risk factors of declined linear growth in children under 2 years.	• Maternal education (≤9 y; RR 2.60)[*] • Maternal employment (working; RR 0.17)[*]

Authors/ Year	Design	Sample	Study Objectives	Findings
Sartika et al/ 2021	Cross-sectional	559 infants aged 0-11 months	To determine important factors of childhood stunting with a focus on maternal and child nutrition, and pre-postnatal determinants	Adjusted with LBW • LBW (aOR 4.119)** • Diarrhea (aOR 3.227)*** • Preterm birth (aOR 5.10)* • Incomplete immunization (aOR 2.43)*
Titaley et al/ 2019	Secondary data analysis	24,657 children aged <2 years	To examine the determinants of stunting in children aged 0-2 years in Indonesia using data derived from the 2013 Indonesia Basic Health Survey	• Number of HH members under 5 years (>3; aOR 1.33)* • Number of HH members (5-7; aOR 1.1)** • HH wealth (poorest; aOR 1.74)*** • Prenatal care visitation (1-3 times; aOR 1.22)** • Gender (male; aOR 1.33)*** • Age of child (12-23 mo; aOR 1.89)*** • LBW (aOR 2.55)***
Nurhayati et al/ 2020	Case-control	158 children aged 6-23 months (79 cases; 79 control)	To examine the association between dietary diversity and vitamin D intake with stunting in children aged 6-23 months	• Age of child (18-23 mo; OR 3.80)* • BL (≥48 cm; OR 0.36)* • Poor micronutrient quality (vitamin D; OR 5.18)* • Dietary diversity (≥4 food groups; OR 0.17)*
Madinar et al/ 2021	Cross-sectional	231 children aged 6-23 months	To determine the factors related to stunting occurrence among children aged 6-23 months.	• Unmet MAD* (OR 3.29) • Short BL* (OR 0.471) • Family income level** (OR 0.387)
Utami et al/ 2018	Cohort	320 children aged <23 months	To determine the major factors of stunting among children aged 0-23 months	• LBW (<3000 gr; HR 1.847)*** • BL (<48 cm; HR 1.567)* • Maternal height (<150 cm; HR 1.436)*
Hanifah et al/ 2018	Secondary data analysis	4,677 children aged 0-23 months in 2000, 2007, and 2014	To determine the stunting trend and associated factors between 2000 and 2014	In 2000: • Age of child*** • LBW* • Maternal education status** • Completeness of prenatal care** • Inadequate sanitation*** • Completeness of immunization* In 2014: • Age of child*** • BW***

Authors/ Year	Design	Sample	Study Objectives	Findings
				• Provision of prelacteal*** • Ownership of Mother and Child Health Book/ Card** • Inadequate sanitation*
Diana et al/ 2021	Cohort	230 healthy full term, breastfed infants	To reduce the burden of early-life linear growth faltering in low- and middle-income countries, interventions have focused on nutrition strategies, sometimes combined with WASH	Stunting between 6 and 12 mo • Maternal height, cm (SMD 0.21)** • Improved drinking water source (SMD - 0.31)*
Hijra et al/ 2016	Case control	116 children aged 12-24 months (58 cases and 58 controls)	To analyze inappropriate complementary feeding practice and infectious diseases as risk factors for stunting in children aged 12-24 months	• Inadequate complementary feeding practices and quality (OR 8.26)*** • URI (OR 5.3)* • Diarrhea (OR 4.73)* • BL (OR 5.11)**
Febriana and Nurhaeni/ 2019	Cross-sectional	143 children aged 6-23 months	To examine the relationship between infant and young child feeding practices (aged 6-23 months) and stunting in East Jakarta	• Age of child* • LBW+
Fentiana et al/ 2022	Secondary data analysis	Children aged 0-23 months from 165 districts/cities in Indonesia	To discover the path of the relationship between various risk factors and the stunting prevalence of ≥30% in 165 districts/cities in Indonesia.	Factor decreasing stunting rates: • Prenatal care* by 2.56% • Contraceptive use* by 2.25% • Handwashing with soap** by 5.76%
Puspita et al/ 2022	Case-control	82 children under two years (41 cases and 41 controls)	To determine the influence of direct and indirect factors on nutritional status to prevent stunting in children	• Prenatal care* (OR 3.61) • Exclusive BF* (OR 3.31) • Parenting feeding pattern** (OR 6.33)
Lewa et al/ 2019	Case-control	80 children aged 6-23 months (40 cases and 40 controls)	To find out the risk factors for stunting in the age group 6---23 months in the Biromaru Public Health Center	• BL** (OR 4.5) • Parity >3 children* (OR 0.85)

HR, hazard ratio; RR, relative risk; OR, odds ratio; aOR, adjusted odds ratio; BF, breastfeeding; BL, birth length; BW, birth weight; HH, household; LBW, low birth weight; MAD, minimum acceptable diet; SMD, standardized mean difference; URI, upper respiratory infection; mo, months; *p value<0.05; **p value<0.01; ***p value<0.001; +p value <0.1